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(71) Applicant: Samsung Electronics Co., Ltd.
Suwon-City, Kyungi-do (KR)

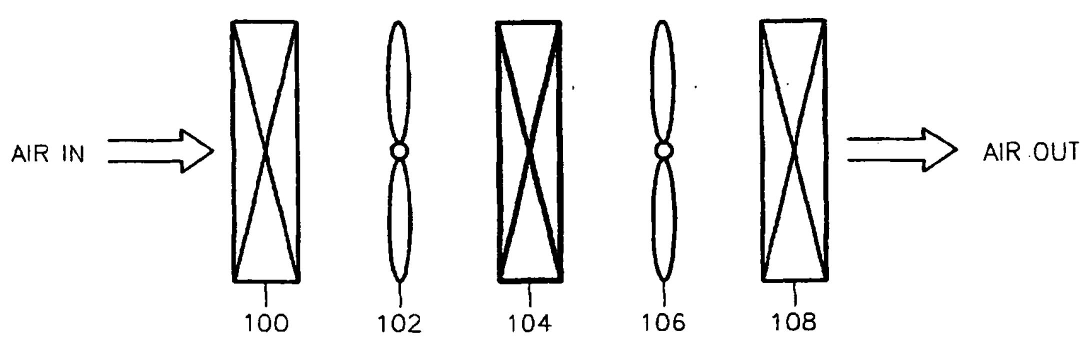
(72) Inventors:
- Yang, Chang-Jip
Suwon-City, Kyungki-Do (KR)
- Youk, Geun-Mok
Yongin-City, Kyungki-Do (KR)
- Cho, Chong-Hyeong
Yongin-City, Kyungki-Do (KR)
- Park, Young-Kyou
Songpa-Gu, Seoul (KR)

(74) Representative: Finnie, Peter John
Elkington and Fife,
Prospect House,
8 Pembroke Road
Sevenoaks, Kent TN13 1XR (GB)

(54) An air intake apparatus for semiconductor fabricating equipment

(57) An air intake apparatus for semiconductor fabricating equipment which is capable of suppressing the inflow of chemical contaminants such as ozone (O_3) into the equipment. The air intake apparatus has a pre-filter (100), a fan as air intake means and a high efficiency particle air (HEPA) filter (108), and also includes a chemical filter (104) containing activated carbon for removing chemical contaminants from the air inflown via the air intake apparatus. By applying the air intake apparatus to a chemical vapor deposition (CVD) used in a process sensitive to a native oxide layer. e.g., forming hemispherical grains (HSGs), the ozone density is decreased, thereby resulting in high capacitance.

FIG. 3



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Description

[0001] The present invention relates to an equipment for semiconductor fabrication, and more particularly, to an air intake apparatus installed in semiconductor fabricating equipment.

[0002] Fine particles or chemicals may contaminate a highly integrated semiconductor device during fabrication, lowering quality. Particularly, in a very large-scale integrated semiconductor device such as a 1 Gb DRAM having 0.18μm line width, process trouble by fine particles or chemicals may occur in unexpected field during fabrication process. Thus, in the view of particle contaminants, careful attention is required to suppress particle contaminants, and reappraisal of conventional semiconductor fabricating equipment is required for fabricating a very large-scale integrated semiconductor device. Particularly, a process and semiconductor fabricating equipment which causes process variation when influenced by environmental factors such as fine particles and chemicals, must be thoroughly verified. General semiconductor fabricating equipment uses various types of filter in order to block particles which may be taken therein. However, most filters can remove only solid particles, i.e., particle contaminants, and not chemical contaminants. As a result, ozone (O_3), oxygen-nitrogen compounds (NO_x), and oxygen-sulfur compounds (SO_x) contained in air flow into semiconductor fabricating equipment via the filter, without being eliminated by the filter. The O_3, NO_x and SO_x cause a chemical reaction in wafer under processing, thereby deteriorating the resultant semiconductor device. There are many types of semiconductor fabricating equipment which is sensitive to chemical contaminants. However, such contamination by chemicals is especially serious in a chemical vapor deposition (CVD) equipment used in a hemispherical polysilicon grain process which is sensitive to a native oxide layer.

[0003] FIGs. 1 and 2 show conventional air intakes for semiconductor fabricating equipment. FIG 1 shows an air intake apparatus which is mainly used when the air intake path is relatively short, and FIG. 2 shows an air intake apparatus which is mainly used when the air intake path is relatively long. The air intake apparatus includes a fan 10 (20) for drawing air from the outside into the equipment, and a high efficiency particle air (HEPA) filter 12 (22) for removing particle contaminants contained in the air. That is, after drawing in air from the outside via the fan 10 (20), the particle contaminants in the air are eliminated using the HEPA filter 12 (22). Preference numeral 14 of FIG. 1 represents a pre-filter for eliminating rough particle contaminants before the fan 10.

[0004] However, since the above-described air intake apparatus for semiconductor fabricating equipment cannot remove chemical contaminants existing in the air, such as O_3, NO_x and SO_x, the chemicals are inflown to the equipment, thereby deteriorating the quality of a semiconductor device under process. The problem of deterioration of a semiconductor device is particularly serious in a CVD equipment used in a hemispherical polysilicon grain process which is sensitive to a native oxide layer.

[0005] According to a first aspect of the present invention, there is provided an air intake apparatus for semiconductor fabricating equipment comprising in sequence: air intake means for drawing in air from outside; a chemical filter for removing chemical contaminants from the air passed through the air intake means; and a high efficiency particle air (HEPA) filter for removing particle contaminants from the air passed through the chemical filter.

[0006] According to a second aspect of the present invention, there is provided an air intake apparatus of a semiconductor fabricating equipment comprising in sequence: air intake means for drawing in air from outside: a high efficiency particle air (HEPA) filter for removing particle contaminants from the air passed through the air intake means; and a chemical filter for removing chemical contaminants from the air passed through the HEPA filter.

[0007] Preferably, the air intake apparatus further comprises a pre-filter before the air intake means. The air intake apparatus may further comprise a fan for offsetting a loss in air pressure, between the chemical filter and the HEPA filter. Also, the air intake means may be a fan. Preferably, the pre-filter has air intake holes which are larger than those of the HEPA filter.

[0008] Preferably, the chemical filter contains activated carbon, and the chemical filter has a structure in which air intake holes are formed in its body containing active carbon.

[0009] According to a third aspect of the present invention, there is provided a method for removing chemical contaminants using an air intake apparatus for semiconductor fabricating equipment, the air intake apparatus including in sequence air intake means, a chemical filter, and a high efficiency particle air (HEPA) filter in which the method comprises the steps of: (a) drawing in air from outside into the equipment using the air intake means; (b) removing chemical contaminants from the drawn in air using the chemical filter; and (c) removing particle contaminants from the air from which the chemical contaminants have been removed, using the HEPA filter.

[0010] According to a fourth aspect of the present invention, there is provided a method for removing chemical contaminants using an air intake apparatus for semiconductor fabricating equipment, the air intake apparatus including in sequence air intake means. a high efficiency particle air (HEPA) filter and a chemical filter, in which the method comprises the steps of: (a) drawing in air from outside into the equipment, using the air intake means; (b) removing particle contaminants from the drawn in air using the HEPA filter; and (c) removing the chemical contaminants from the air from which the

particle contaminants have been removed, using the chemical filter.
Preferably, the step (a) is simultaneously performed by the step of removing particle contaminants from the drawn in air by further including a pre-filter before the air intake means. Also, the method may further comprise the step of offsetting a loss in pressure of the air passed through the HEPA filter by further including a fan between the HEPA filter and the chemical filter, before the step (c).

[0011] Preferably, the pre-filter has air intake holes which are larger than those of the HEPA filter, and the air intake means adopts a fan. Also, the step (b) of the method may comprise the sub-steps of removing the chemical contaminants through a chemical reaction where activated carbon on the surface of the chemical filter absorbs ozone from the air.

[0012] Examples of the present invention will now be described in detail with reference to the accompanying drawings, in which:

FIGs. 1 and 2 show conventional air intakes for semiconductor fabricating equipment;
FIGs. 3 through 5 illustrate an air intake apparatus for semiconductor fabricating equipment and a method for removing chemical contaminants using the apparatus, according to one preferred example of the present invention;
FIGs. 6 and 7 illustrate an air intake apparatus for semiconductor fabricating equipment and a method for removing chemical contaminants using the apparatus, according to another preferred example of the present invention; and
FIGs. 8 through 10 are graphs showing the results when the air intake apparatus of the present invention is applied to chemical vapor deposition (CVD) equipment used in a hemispherical polysilicon grain (HSG) process.

[0013] In the following, a chemical filter includes the widest meaning and is not limited to a specific shape or structure. In the following examples, the body of the chemical filter, having air intake holes and containing activated carbon, is rectangular. However, the shape of the chemical filter's body may be modified into a circle, an ellipse or a polygon. Also, the air intake holes of the chemical filter are shaped as rounded zigzags. However, the arrangement of the air intake holes may be modified. Thus, this invention should not be construed as limited to the embodiments set forth herein.

Example 1

[0014] FIG. 3 is a side view of the air intake apparatus for semiconductor fabricating equipment according to the present invention, when the air intake path is long. First. particle contaminants which are relatively large are eliminated by a pre-filter 100. Then, the air is drawn into the air intake apparatus by a first fan which corresponds to an air intake means 102, for filtering. Then, chemical contaminants remaining in the air, such as ozone (O_3), are eliminated from the air by a chemical filter 104. Here, if the air intake path is long, pressure of the air inflown via the first pan as the air intake means 102 may decrease while passing through the chemical filter 104. Thus, a second fan 106 is operated in order to supplement the reduced air pressure, such that the air passed through the chemical filter 104 reaches a high efficiency particle air (HEPA) filter 108 for removing particle contaminants. The remaining particle contaminants are removed by the HEPA filter 108. Therefore, the air intake apparatus of a semiconductor fabricating equipment according to the present invention removes chemical contaminants as well as particle contaminants from the air taken from the outside, thereby improving performance of a semiconductor device which is processed by the semiconductor fabricating equipment.

[0015] The pre-filter 100 removes particles from the air in the same manner as the HEPA filter 108. However, the size of air intake holes formed in the pre-filter 100 are larger than those formed in the HEPA filter 108.

[0016] FIG. 4 is a side view of the air intake apparatus for semiconductor fabricating equipment according to the present invention when the air intake path is short. Compared with FIG. 3, there is no second fan between the chemical filter 104 and HEPA filter 108 even though the air intake apparatus includes a pre-filter 100, an air intake means 102 as a first fan, a chemical filter 104 and a HEPA filter 108 as in the air intake apparatus of FIG. 3. Because there is little loss in air pressure after the air passes through the chemical filter 104, due to the short air intake path. That is, the air intake apparatus is effective when little pressure loss occurs because of relatively short air intake path.

[0017] FIG. 5 is an enlarged view of the chemical filter shown in FIGs. 3 and 4. In detail. the chemical filter is obtained by chemically processing to the surface of a general filter such that chemical contaminants containing in air are absorbed by a chemical reaction. The chemical filter of the present invention is for removing ozone (O_3) from the air. by using activated carbon in the surface of a body 110 thereof. Also, the chemical filter body 110 has a plurality of air intake holes 112.

[0018] Here, in an outermost layer 114 of the body 110 of the chemical filter, the air intake holes are repeatedly arranged in rounded zigzags such that the activated carbon component is spread thereover as wide as possible. Thus, chemical contaminants, such as ozone (O_3), oxygen-nitrogen compound (NO_x) and oxygen-sulfur compound (SO_x), passing through the air intake holes 112, are absorbed by the activated carbon, thereby producing carbon dioxide (CO_2) as the reaction product. That is, the ozone component passing through the chemical filter is removed because oxygen and carbon element produce carbon dioxide (CO_2) by a chemical reaction. Preferably, the body 110 of the chemical filter is com-

prised of a plurality of layers. Here, in a second layer 116 next to the outermost layer 114, air intake holes are rounded zigzags at 90°. to those of the outermost layer 114. Thus, while passing through the chemical filter. there is more chance of the oxygen contained in the chemical contaminants of the air reacting with the carbon of the activated carbon, so ozone may be effectively removed. Thus, the above chemical filter can increase its ozone removing effect by changing the structure of the chemical filter body 110 as 90° rounded zigzags in second layer 116 while an outermost layer 114 has the zigzags type body structure. Here, reference numeral 118 represents a chemical filter mounting portion used to install the chemical filter in semiconductor fabricating equipment.

[0019] Now, a method for removing chemical contaminants, using the air intake apparatus for semiconductor fabricating equipment, will be described with reference to FIGs. 3 through 5.

[0020] First, the air intake means 102 (the first fan) of FIG. 3 is operated to draw in air from the outside. Here, the pre-filter 100 which is installed at the leading end of the air intake means 102 removes a comparatively large particle contaminants at first from the inflown air. Then, the air passes through the air intake holes 112 (see FIG. 5) of the chemical filter 104. Here, oxygen contained in the chemical components such as ozone (O_3), oxygen-nitrogen compounds (NO_x) and oxygen-sulfur compounds (SO_x), passing through the air intake holes 112, combine with the activated carbon contained in the chemical filter body 110, thereby producing carbon dioxide (CO_2). As a result. the ozone of the air is removed. If the air intake path is long, loss in air pressure occurs while passing through the chemical filter 104. However, such loss in air pressure is made up for by operating the second fan 106 between the chemical filter 104 and the HEPA filter 108. If the air intake path is short, and loss in air pressure is negligible while passing through the chemical filter 104, then using the second filter 106 is not necessary. Finally, fine particle contaminants reaching the HEPA 108 by operating the second fan 106 are removed. Here, the air intake holes of the HEPA filter 108 are smaller than those of the pre-filter 100. That is, the fine particle contaminants are removed via two steps by the pro-filter 100 and the HEPA filter 108.

Example 2

[0021] While the first example places the chemical filter after the first fan as the air intake means, the second example places the HEPA filter after the first fan and then the chemical filter after the HEPA filter.

[0022] FIG. 6 is a side view of the air intake apparatus which is suitable when the air intake path is long. The air intake apparatus includes a pre-filter 200 located at the leading end of the air intake path, a first fan as an air intake means 202, a HEPA filter 208 installed directly after the air intake means 202, a second fan 206 for supplementing loss in pressure, and a chemical filter 204 installed at the end of the air intake path. The structure and the role of each unit constituting the air intake apparatus are the same as those of the first example, thus explanation thereof will be omitted.

[0023] FIG. 7 is a side view of the air intake apparatus which is suitable when the air intake path is short. The structure of the air intake apparatus shown in FIG. 7 is different from that of FIG. 6 only in that there is no second fan since loss in air pressure is negligible when passing through the HEPA filter 208, due to the short air intake path.

[0024] Now, a method for removing chemical contaminants using the air intake apparatus of a semiconductor fabricating equipment according to the second example of the present invention will be described with reference to FIGs. 6 and 7.

[0025] First, air is taken from the outside of the semiconductor fabricating equipment by operating the first fan as the air intake means 202 of FIG. 6. Here, the pre-filter 200 is installed at the leading of the air intake means 202 to remove comparatively large particle contaminants from the taken air. Then, fine particle contaminants are removed by the HEPA filter 208 from the inflown air. Here, if the air intake path is long, loss in pressure occurs while passing through the HEPA filter 208, and such loss in pressure is compensated for by operating the second fan 206 installed between the HEPA filter 208 and the chemical filter 204. On the other hand, if the air intake path is short, the second fan 206 is not necessary since loss in air pressure is negligible. Finally, oxygen components of the chemical contaminants such as ozone (O_3), oxygen-nitrogen compounds (NO_x) and oxygen-sulfur compounds (So_x) are combined with the activated carbon contained in the body of the chemical filter while passing through the air intake holes of the chemical filter, thereby producing carbon dioxide (CO_2) at the chemical filter 204. As a result. the ozone is removed from the air.

Experimental Example

[0026] The HSG process is for increasing capacitance by increasing the surface area of a capacitor storage electrode in DRAM, and is adopted when a very large scale DRAM is fabricated. The increase of the surface is achieved by forming HSGs on the surface of the storage electrode. The mechanism of forming the HSGs is as follows. First, small amorphous silicon seeds are formed on polysilicon constituting the storage electrode of a capacitor. Then, under a vacuum and at an appropriate temperature, polysilicon atoms of the storage electrode migrate to near the small amorphous silicon seeds, thereby growing the small amorphous silicon seeds into grains on the surface of the storage electrode of the capacitor.

[0027] However, if chemical contaminants such as ozone are inflown via the air intake apparatus of the

CVD equipment, a native oxide (SiO_2) layer is formed on the surface of the polysilicon of the storage electrode during HSG growing process. The native oxide layer prevents the migration of the polysilicon atoms around the small amorphous silicon seeds, so that the size of the HSG is reduced, thereby lowering performance of the DRAM because of lower capacitance.

[0028] FIG. 8 is a graph showing reflective index measured at the surface of polysilcon of the storage electrode during the HSG growing process. versus ozone density within the CVD equipment. Generally, when ozone is flowed into semiconductor fabricating equipment, the native oxide layer is formed, thereby increasing reflective index. In FIG. 8, the X-axis represents ozone density (ppb) and the Y-axis represents reflective index. As can be seen from the graph, the ozone density and the reflective index have a direct proportional relationship. That is, as the ozone density increases, the reflective index increases due to the effect of the natural oxide layer formed by the ozone.

[0029] FIG. 9 is a graph showing a correlation between the reflective index at the surface of the capacitor storage electrode and the minimum capacitance (Cmin) of the capacitor, during the HSG growing process. In FIG. 9, the X-axis represents the reflective index, and the Y-axis represent the minimum capacitance (Cmin). Here, because the reflective index and the minimum capacitance (Cmin) have an inverse proportional relationship, the minimum capacitance decreases as the reflective index increases. That is, a higher reflective index prevents the growth of the HSGs, thereby causing difficulties in obtaining a higher capacitance. From the results of FIGs. 8 and 9, it can be understood that the size of the HSGs of the capacitor storage electrode decreases as the ozone density increases, thereby decreasing capacitance.

[0030] FIG. 10 is a graph showing the ozone removing capability of the air intake apparatus according to the present invention, which is installed at the top and side of the CVD equipment used for the HSG process. Here, the graph with circles (-o-o-) represents the ozone density inside the equipment, that is, the ozone density after the chemical contaminants such as ozone have been reduced by the air intake apparatus. The graph with rectangles (-□-□-) represents the ozone density outside the equipment, that is, the ozone density before the chemical and particle contaminants are filtered. Here, the X-axis represents the time at which each measurment was performed, and the Y-axis represents ozone density (ppb).

[0031] As can be seen from FIG. 10, by installing the air intake apparatus according to the present invention to the CVD equipment used for the HSG process, the ozone density inside the equipment is markedly decreased. In terms of percentage, the internal ozone density is decreased by an average of 57.3% compared with outside ozone density. Accordingly, due to the decreasing of the ozone density, the HSGs grow larger during the HSG process, thereby increasing the capacitance in a small area. As described above, the air intake apparatus for semiconductor fabricating equipment includes a chemical filter capable of removing chemical contaminants, so that deterioration of a semiconductor device, caused by the chemical contaminants, can be improved.

Claims

1. An air intake apparatus for semiconductor fabricating equipment comprising in sequence:

   air intake means (102) for drawing in air from outside;
   a chemical filter (104) for removing chemical contaminants from the air passed through the air intake means; and,
   a high efficiency particle air (HEPA) filter (108) for removing particle contaminants from the air passed through the chemical filter (104).

2. An air intake apparatus of a semiconductor fabricating equipment comprising in sequence:

   air intake means (102) for drawing in air from outside:
   a high efficiency particle air (HEPA) filter (108) for removing particle contaminants from the air passed through the air intake means; and,
   a chemical filter (104) for removing chemical contaminants from the air passed through the HEPA filter (108).

3. An air intake apparatus according to claims 1 or 2, in which the air intake means (102) is a fan.

4. An air intake apparatus according to claim 1 or 2, in which the chemical filter (104) has a structure in which air intake holes are formed in its body containing active carbon.

5. An air intake apparatus according to claims 3 or 4 when dependent on claim 1 wherein the air intake apparatus further comprises a pre-filter (100) capable of removing particle contaminants, before the air intake means (102).

6. An air intake apparatus of claim 5, in which the prefilter (100) has air intake holes which are larger than those of the HEPA filter (108).

7. An air intake apparatus according to any of claims 3 to 6 when dependent on claim 1, further comprising a fan (106) for offsetting a loss in air pressure, between the chemical filter (104) and the HEPA filter (108).

8. An air intake apparatus according to any of claims 3 to 7 when dependent on claim 1, in which the chemical filter (104) contains activated carbon.

9. A method for removing chemical contaminants using an air intake apparatus for semiconductor fabricating equipment, the air intake apparatus including in sequence air intake means for drawing in air from outside, a chemical filter for removing chemical components from the air, and a high efficiency particle air (HEPA) filter for removing particle contaminants from the air, the method comprising the steps of:

(a) drawing in air from outside into the equipment using the air intake means;
(b) removing chemical contaminants from the drawn in air using the chemical filter; and,
(c) removing particle contaminants from the air from which the chemical contaminants have been removed, using the HEPA filter.

10. A method for removing chemical contaminants using an air intake apparatus for semiconductor fabricating equipment, the air intake apparatus including in sequence air intake means for drawing in air from outside, a high efficiency particle air (HEPA) filter for removing particle contaminants from the air and a chemical filter for removing chemical components from the air, the method comprising the steps of:

(a) drawing in air from outside into the equipment, using the air intake means;
(b) removing particle contaminants from the drawn in air using the HEPA filter; and,
(c) removing the chemical contaminants from the air from which the particle contaminants have been removed, using the chemical filter.

11. A method according to claims 9 or 10, wherein the step (a) is simultaneously performed by the step of removing particle contaminants from the drawn in air by further including a pre-filter before the air intake means.

12. A method according to any of claims 9 to 11, further comprising the step of offsetting a loss in pressure of the air passed through the chemical filter by further including a fan between the chemical filter and the HEPA filter, before the step (c).

13. A method according to any of claims 9 to 12, wherein the step (b) comprises the sub-steps of removing the chemical contaminants through a chemical reaction where activated carbon on the surface of the chemical filter absorbs ozone from the air.

14. A method according to any preceding claim when dependent on claim 10, further comprising the step of offsetting a loss in pressure of the air passed through the HEPA filter by further including a fan between the HEPA filter and the chemical filter, before the step (c).

15. An air intake apparatus for semiconductor fabricating equipment, comprising:

air intake means (102) for drawing air from outside;
a chemical filter (104) for removing chemical contaminants from the air; and,
a high efficiency particle air filter (108) for removing particle contaminants from the air.

16. An air intake apparatus according to claim 15 in which the high efficiency particle air filter (108) is positioned downstream of the chemical filter (104).

17. An air intake apparatus according to claim 15, in which the chemical filter (104) is positioned downstream of the high efficiency particle air filter (108).

18. A method for removing chemical contaminants using an air intake apparatus for semiconductor fabricating equipment according to any of claims 15 to 17, comprising the steps of:

(a) drawing in air from outside into the equipment, using the air intake means;
(b) removing particle contaminants from the air using the high efficiency particle air filter; and,
(c) removing the chemical contaminants from the air using the chemical filter.

FIG. 1 (PRIOR ART)

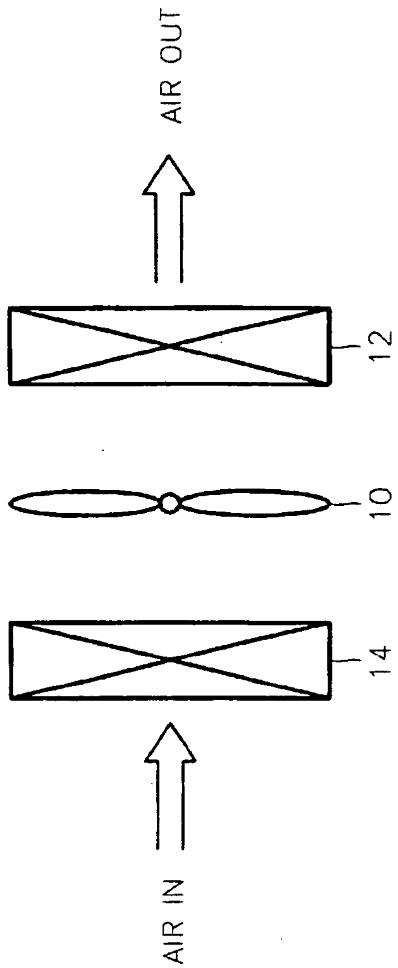


FIG. 2 (PRIOR ART)

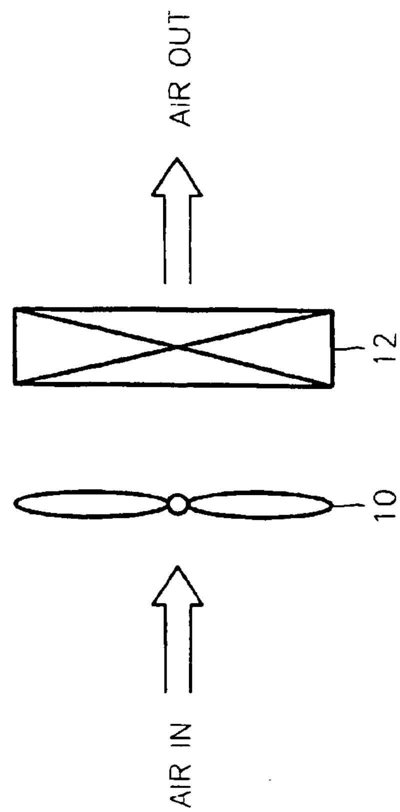


FIG. 3

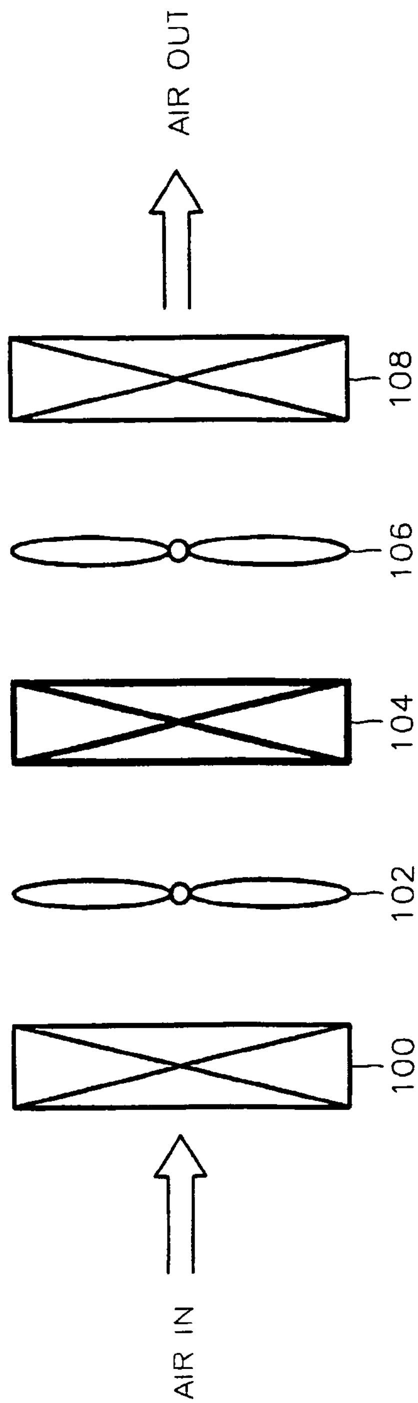


FIG. 4

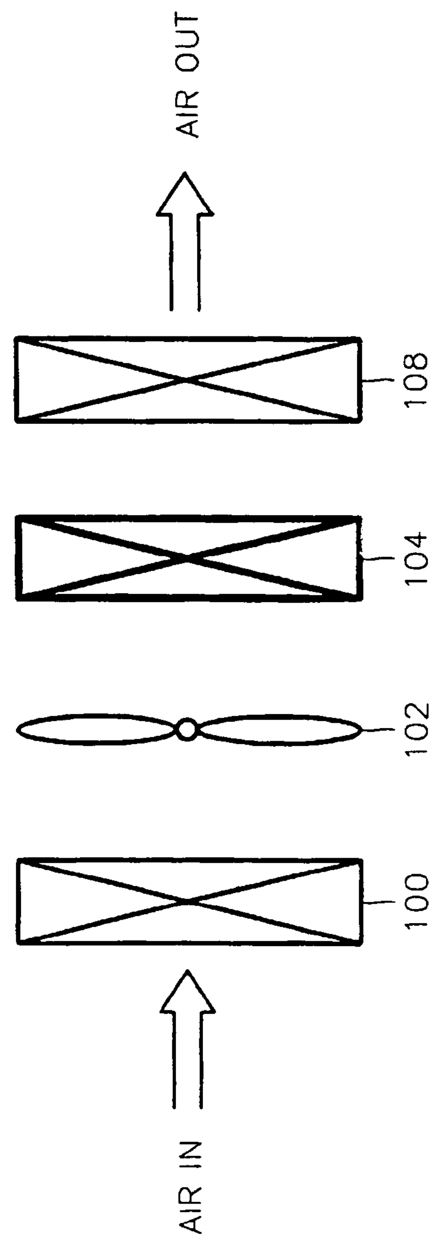


FIG. 5

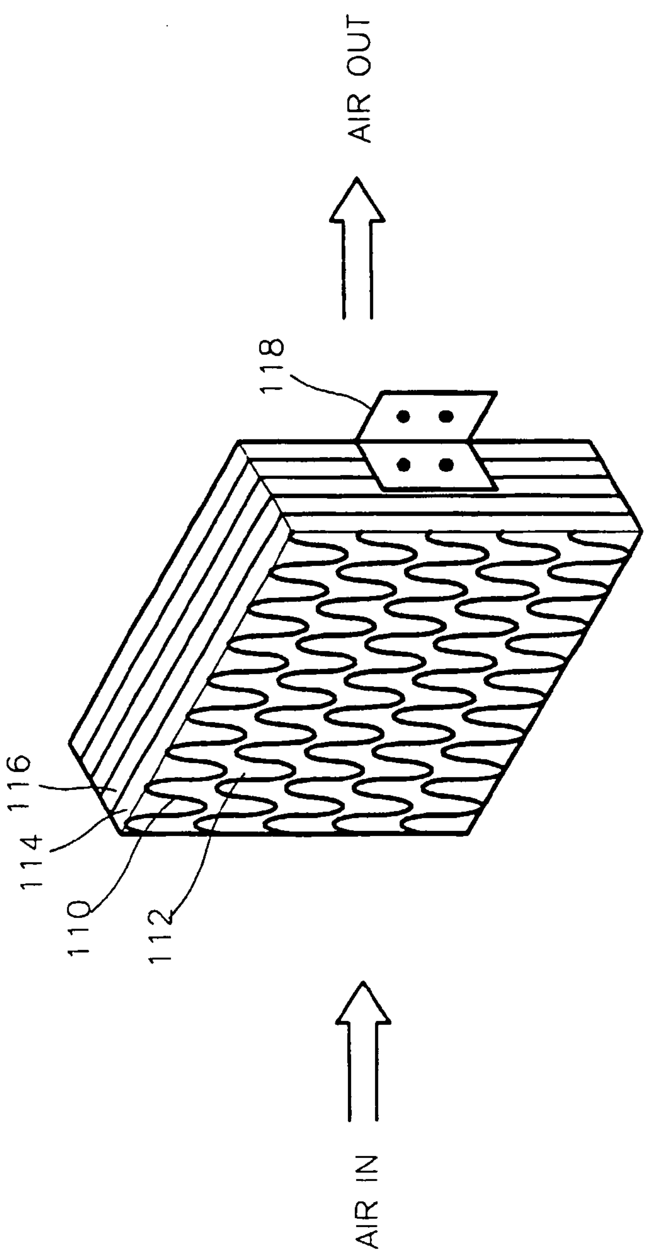


FIG. 6

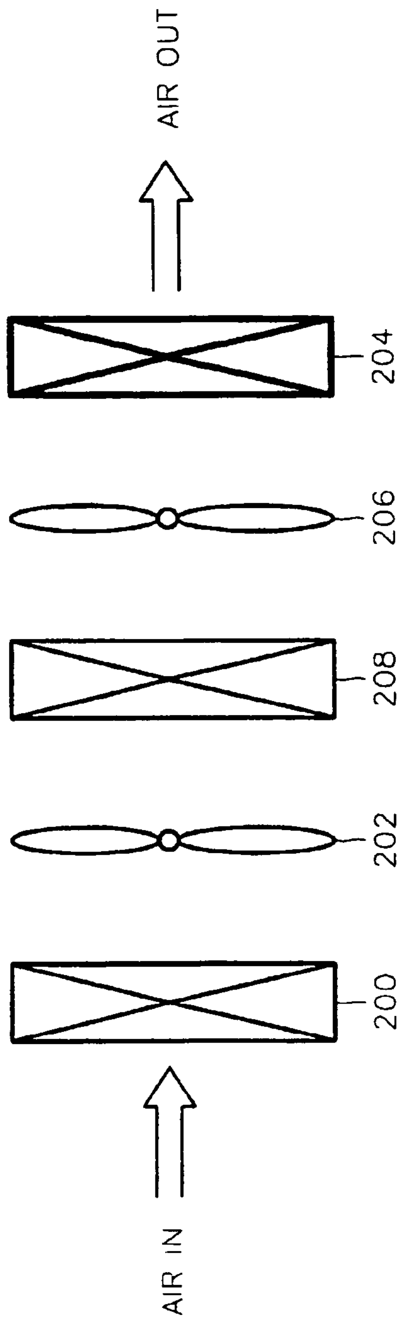
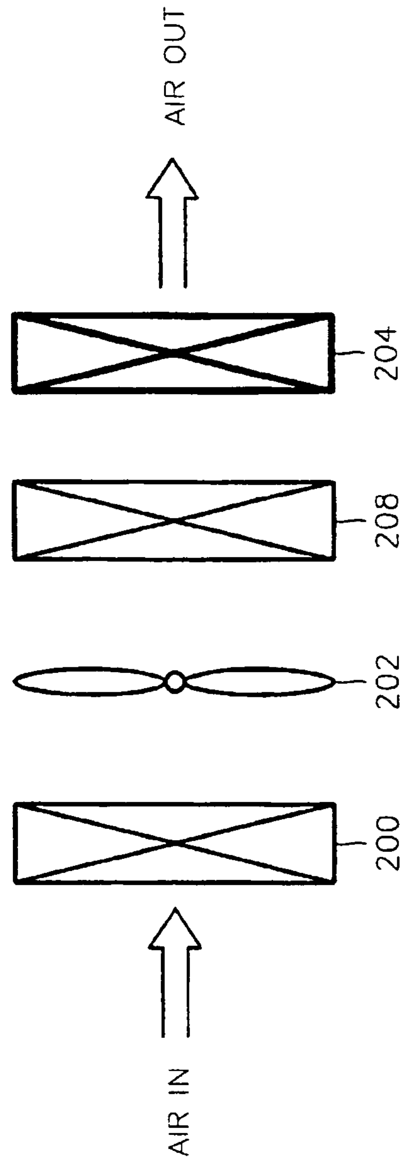
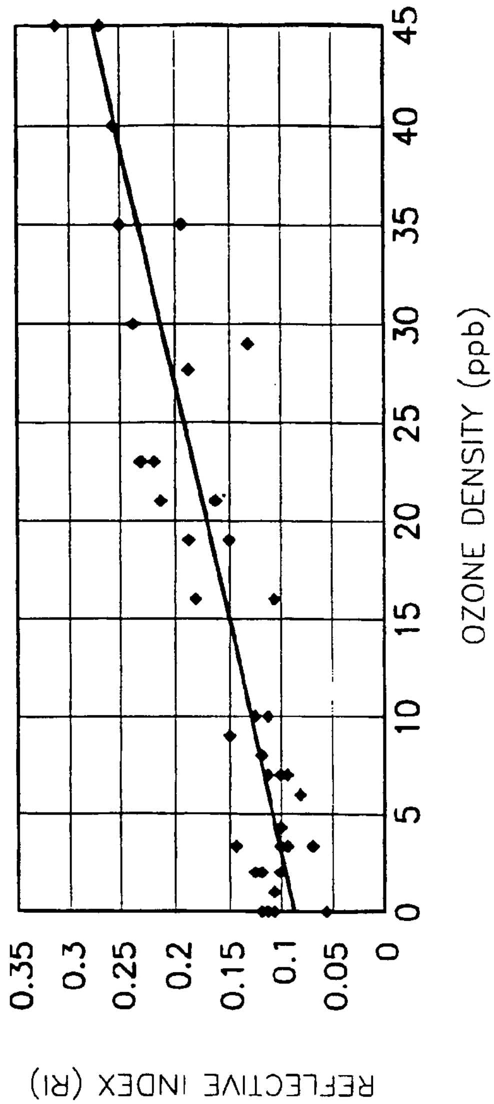


FIG. 7

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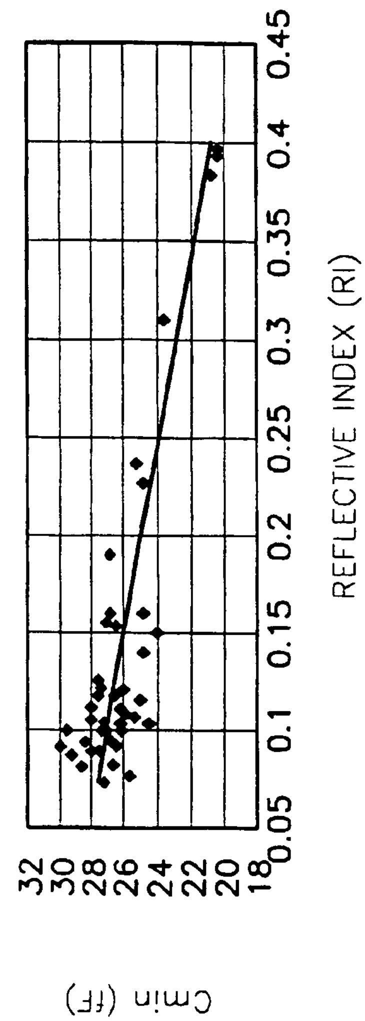
OZONE DENSITY (ppb)

FIG. 8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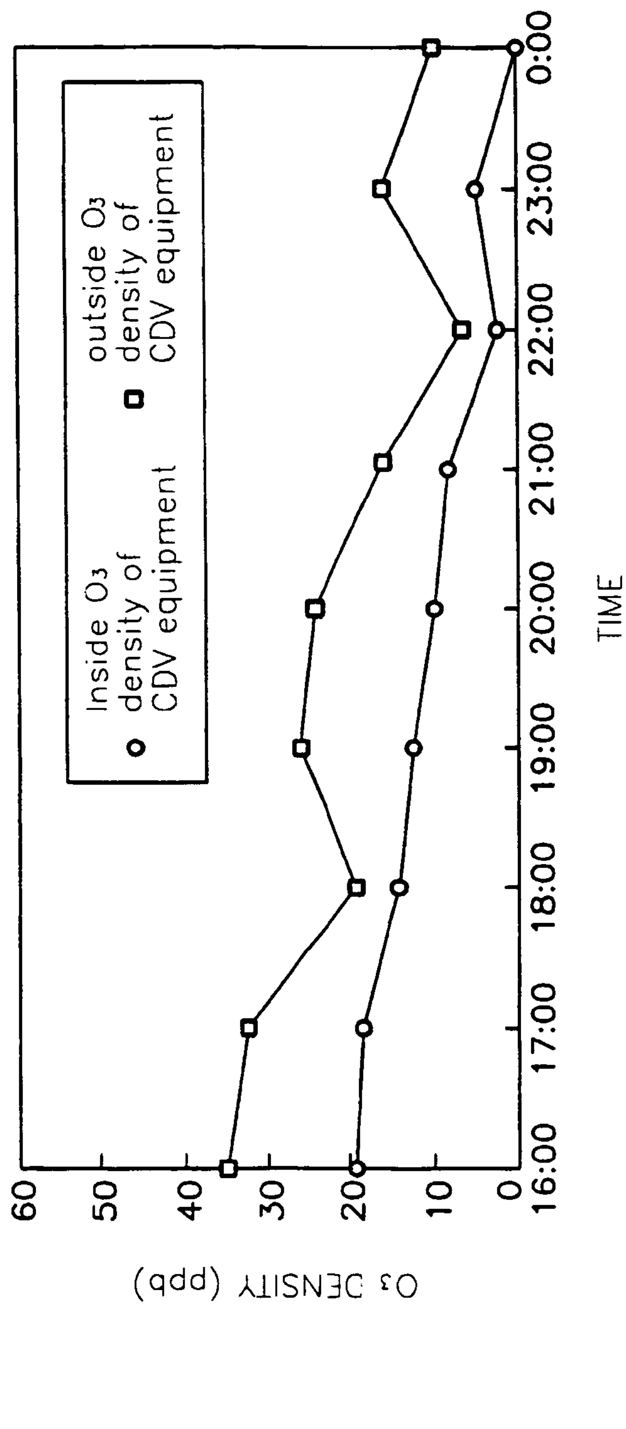
REFLECTIVE INDEX (RI)

FIG. 9

FIG. 10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23:00
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TIME
Inside O3 density of CDV equipment
outside O3 density of CDV equipment

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(71) Applicant: Samsung Electronics Co., Ltd.
Suwon-City, Kyungi-do (KR)

(72) Inventors:
- Yang, Chang-Jip
  Suwon-City, Kyungki-Do (KR)
- Youk, Geun-Mok
  Yongin-City, Kyungki-Do (KR)
- Cho, Chong-Hyeong
  Yongin-City, Kyungki-Do (KR)
- Park, Young-Kyou
  Songpa-Gu, Seoul (KR)

(74) Representative: Finnie, Peter John
Elkington and Fife,
Prospect House,
8 Pembroke Road
Sevenoaks, Kent TN13 1XR (GB)

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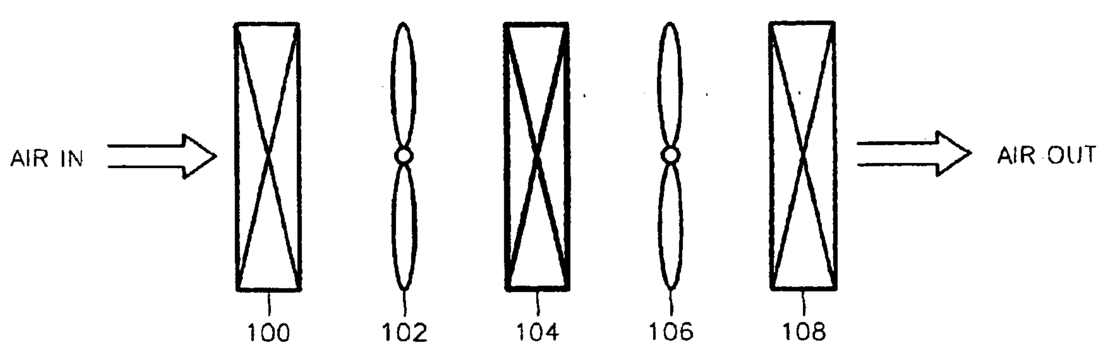
FIG. 3



EP 0 904 826 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 98 30 7710

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
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A	* column 10, line 39 - line 45; figure 1C *	2,7,10, 12-14,17	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	23 March 1999	Bogaerts, M

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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L : document cited for other reasons
& : member of the same patent family, corresponding document

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 98 30 7710

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